

it is not believed that amendment of such claims is required in order to comply with Section 112, second paragraph.

Claims 1-3, 9 and 14-16 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar et al. (U.S. 4,376,688) in view of Fu et al. (U.S. 5,914,018) and King (U.S. 4,108,751).

Claims 4, 5 and 17 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar et al. in view of Fu et al., King and Pinarbasi (U.S. 5,492,605).

Claims 6, 7 and 13 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar et al. in view of Fu et al., King and Quazi (U.S. 4,693,805).

Claim 8 has been rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar et al. in view of Fu et al., King and Arnold (U.S. 5,423,971).

Claims 10 and 11 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Ceasar et al. in view of Fu et al., King and *Ion Beam Neutralization*.

The present invention pertains to sputtering of material from a sputter target onto a deposition substrate in an evacuated volume using an ion source from which the ions leave in the form of an ion efflux having an energy of about 50 eV or less. The sputter target is biased negative relative to ground. The ionizable gas within the evacuated volume is at a first pressure and the gas within the ion source is at a second pressure. Because the ion beam is at a sufficiently low energy,

it can strike other hardware in the vacuum chamber, or the vacuum chamber itself, without causing significant sputtering. Further, the ion energy necessary for sputtering the target is supplied primarily by biasing the target to a negative potential relative to the surrounding vacuum chamber.

In claims 1-3, the sputter target has a curved target surface for enhancing or reducing the arrival of energetic electrons at different locations on a substrate, or onto different substrates.

Claim 4, dependent from claim 1, pertains to sputtering apparatus which further comprises a magnetic field near the sputter target. The magnetic field is able to contain secondary electrons generated by the ion efflux striking the target.

Independent claim 5 pertains to sputtering apparatus having the same elements as claim 1 but further including a magnetic field near the sputter target which is able to contain secondary electrons.

Claims 6 and 7 further specify the type of bias for biasing the target.

Claim 8 further recites a target enclosure for defining the portion of the sputter target that is exposed for sputtering.

Claim 9 further recites that an additional reactive gas is introduced to promote the formation of compounds incorporating both the reactive gas and the material sputtered from the target.

Claims 10-12 specify different types of ion sources which can be used in the apparatus.

Claim 13 recites pulsed operation of the apparatus.

Claims 14-17 recite methods for sputtering material, wherein secondary electrons are accelerated away from the sputter target to form a beam of electrons.

Attached is a Declaration of Harold R. Kaufman, who is one of the named inventors in this application. Dr. Kaufman carefully explains the differences between the present invention and the cited references. The primary references, Ceasar et al. and King, do not describe sputtering apparatus using low energy ions. Rather, such references pertain to the use of high energy ions which must be focused onto the sputter target in order to avoid sputtering of adjacent hardware.

The Fu et al. reference pertains to a direct-current diode which does not produce an ion beam. A direct-current diode requires a negative target bias in order to work. The concave and convex targets shown by Fu et al. are for the purpose of eliminating re-deposition on the target sidewall. In the present invention, the shaping of the target surface is for controlling the trajectories of the secondary electrons that are emitted from the target surface.

Thus, even if these cited references were combined, that would not lead a person of ordinary skill in the art to the presently claimed invention.

The cited Pinarbasi patent refers to the use of a magnetic field within the discharge chamber. Such teaching would not suggest the use of a magnetic field in front of a target for containing secondary electrons.

The Quazi patent refers to a radiofrequency bias in a RF glow discharge. That patent does not teach anything regarding a low energy directed ion beam. Thus, the Quazi patent does not cure the deficiencies of the other cited references.

The Arnold reference refers to a dark space shield in cathode sputtering. This reference does not teach the use of a low energy ion source.

The *Ion Beam Neutralization* technical disclosure describes an end-Hall type of gridless source and a hollow cathode source. Such teaching would not suggest use of an end-Hall ion source in the Ceasar et al. apparatus. The Ceasar et al. patent describes the need to confine almost all of the ion beam by focusing it onto the target. Neither the end-Hall type of gridless source nor the hollow cathode source would satisfy the requirement of Ceasar et al., for an ion beam that is confined to the target (see col. 7, lines 37-52).

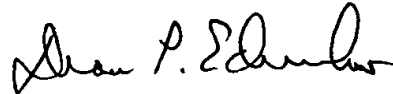
Thus, the *Ion Beam Neutralization* reference also fails to cure the deficiencies of the Ceasar et al. reference.

Combination of the cited references would not lead to the present invention. The references simply do not teach the claimed subject matter, and there is no suggestion in the references which would lead a person of ordinary skill in this

art to attempt combination of the references to obtain the present invention. Even if one attempted such a combination, this still would not lead to the invention as claimed.

With the present amendments to the claims, the attached Declaration, and the foregoing remarks, it is believed that the Section 112, second paragraph, and the Section 103(a) rejections have been overcome. Reconsideration and favorable action are courteously solicited.

Respectfully submitted,



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James R. Kahn et al.

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8. (Amended) A sputtering apparatus as defined in claims 1, 4, or 5 in which said sputter target is enclosed by a target enclosure, where said target enclosure defines [the perimeter of the area] a portion of said sputter target that is exposed for sputtering.